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Fisher, Jr.

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[54] **FLOATING COAXIAL CONNECTOR**

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[51] **Int. Cl.**[4] **H01R 13/434;** H01R 13/64

[52] **U.S. Cl.** **439/246;** 439/556

[58] **Field of Search** ..... 339/64 R, 64 M, 126 RS, 339/126 J, 129, 217 S, 177 R, 177 E

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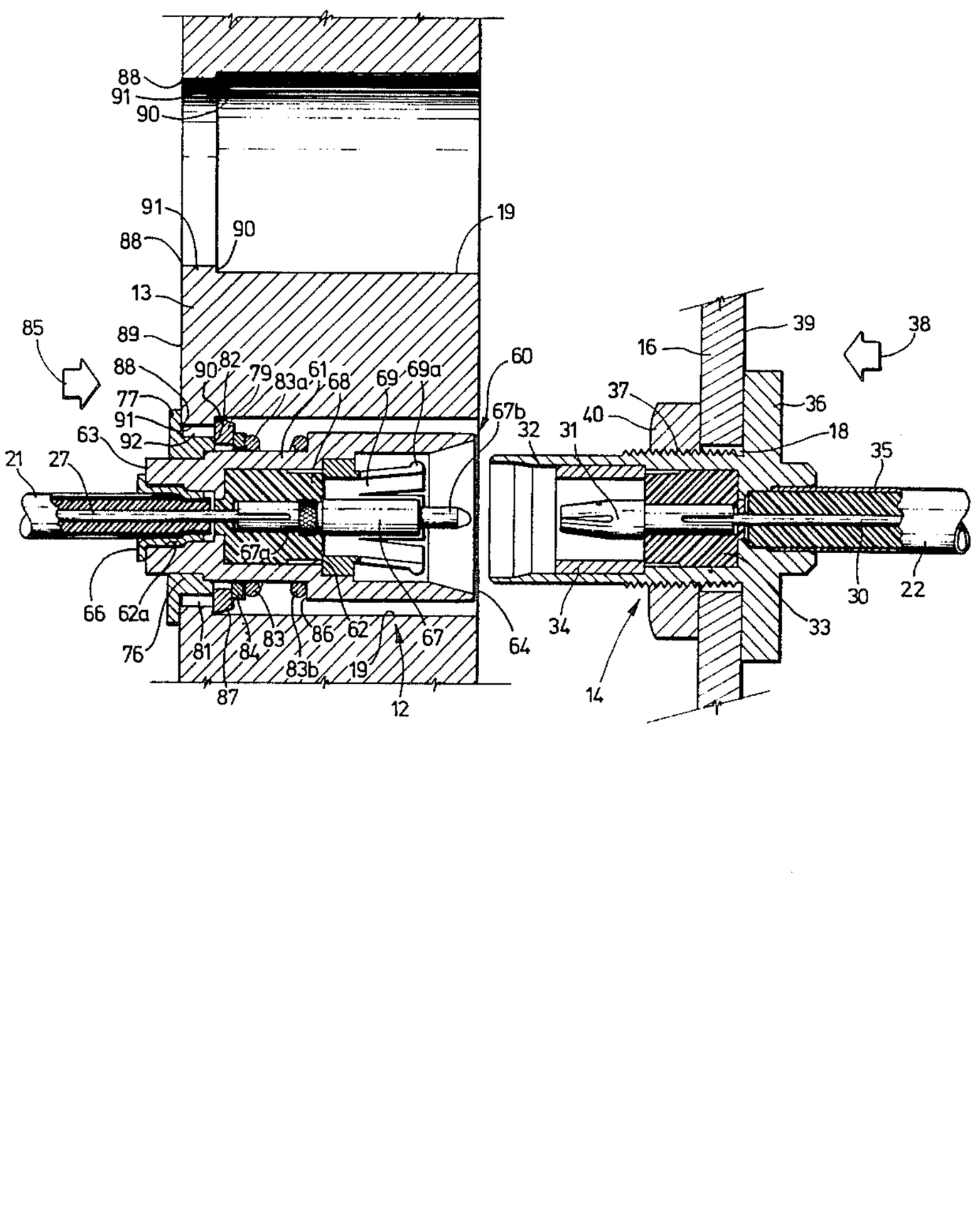
Primary Examiner—Gil Weidenfeld
Assistant Examiner—Gary F. Paumen

[57] **ABSTRACT**

An electrical connector **12** for snap-in mounting in an aperture **19** of a panel **13,** comprises, a connector body **60** having an outer contact **69** and a passageway **62** receiving an outer conductor **26** of a coaxial cable **21,** a grip ring **66** wedged against an internal wall of said passageway **62** and surrounding said outer conductor **26,** a center contact **67** having a rearward portion for fitted connection with a center conductor **27** of the coaxial cable **21,** a tapered surface **102** on a front end of said connector body **60** for impingement by a complementary connector **14** during mating, a split retention ring **79** surrounding the connector body **60** and being compressible inwardly during insertion into the aperture **19** of said panel **13** and thereafter expansible outwardly to engage the panel **13,** a coil spring **83** surrounding the connector body **60** and having one end biased against the connector body **60** and the other end biased against said ring **79** to force the ring **79** against the panel **13,** and a flange **77** on the connector body **60** for engaging against the panel **13.**

10 Claims, 6 Drawing Figures



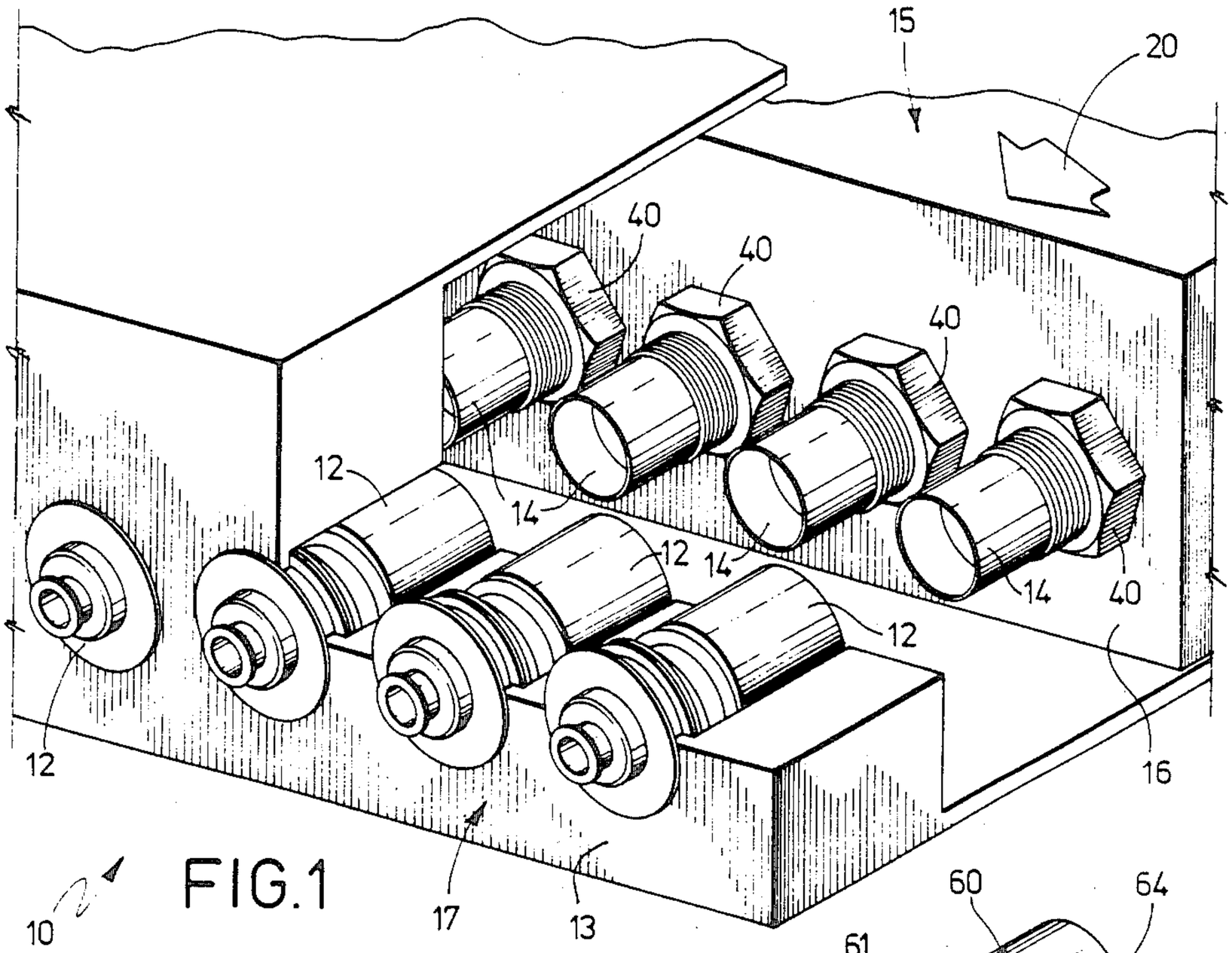

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FIG.1

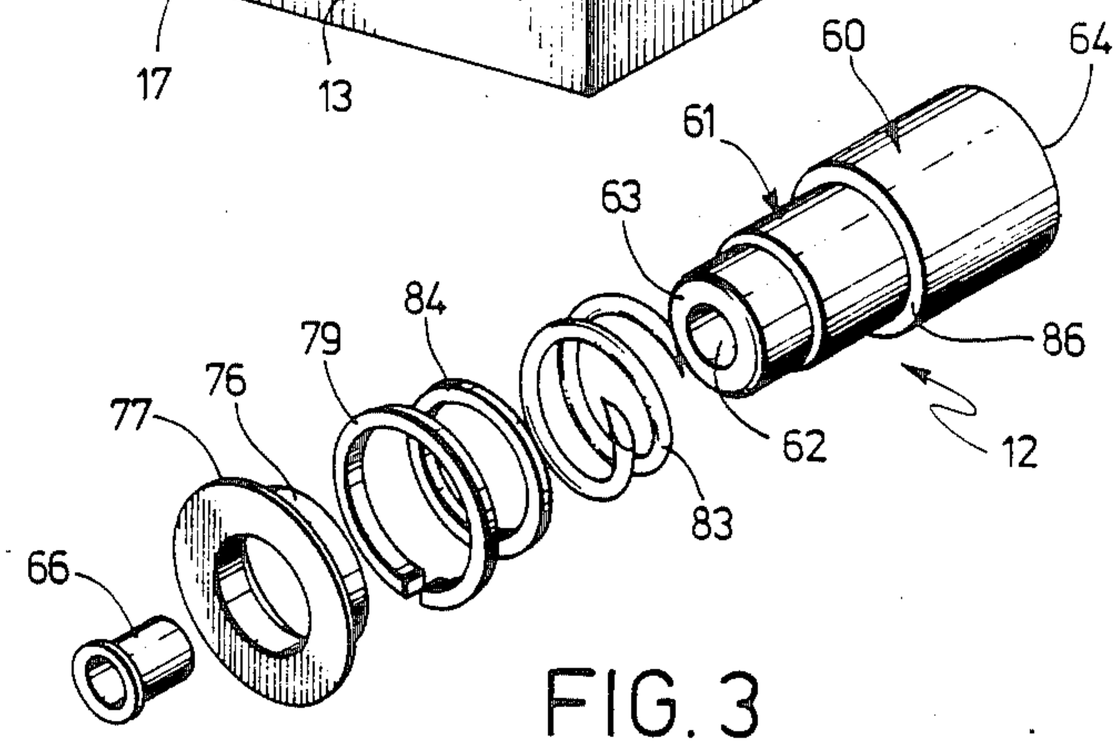
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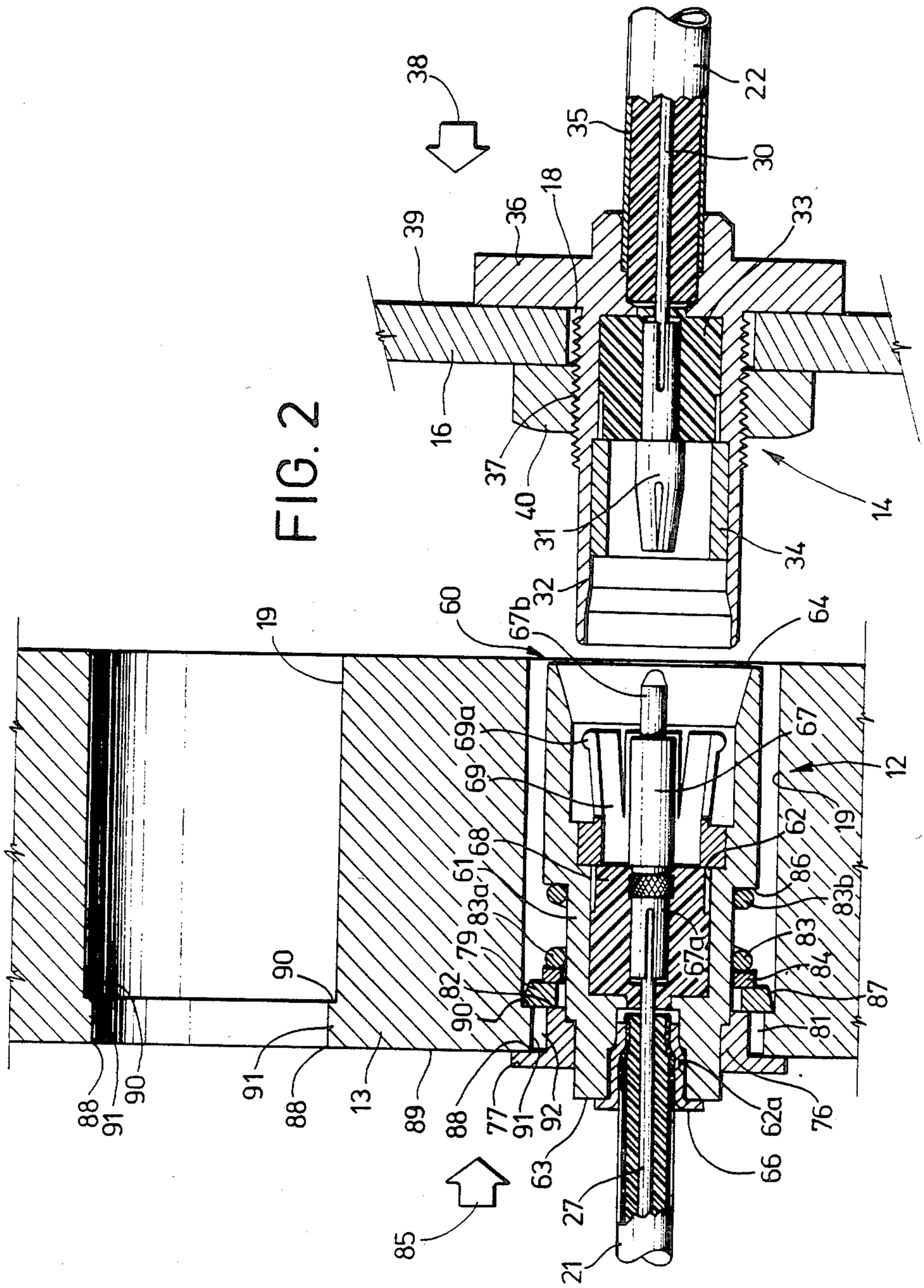
FIG. 3

FIG. 2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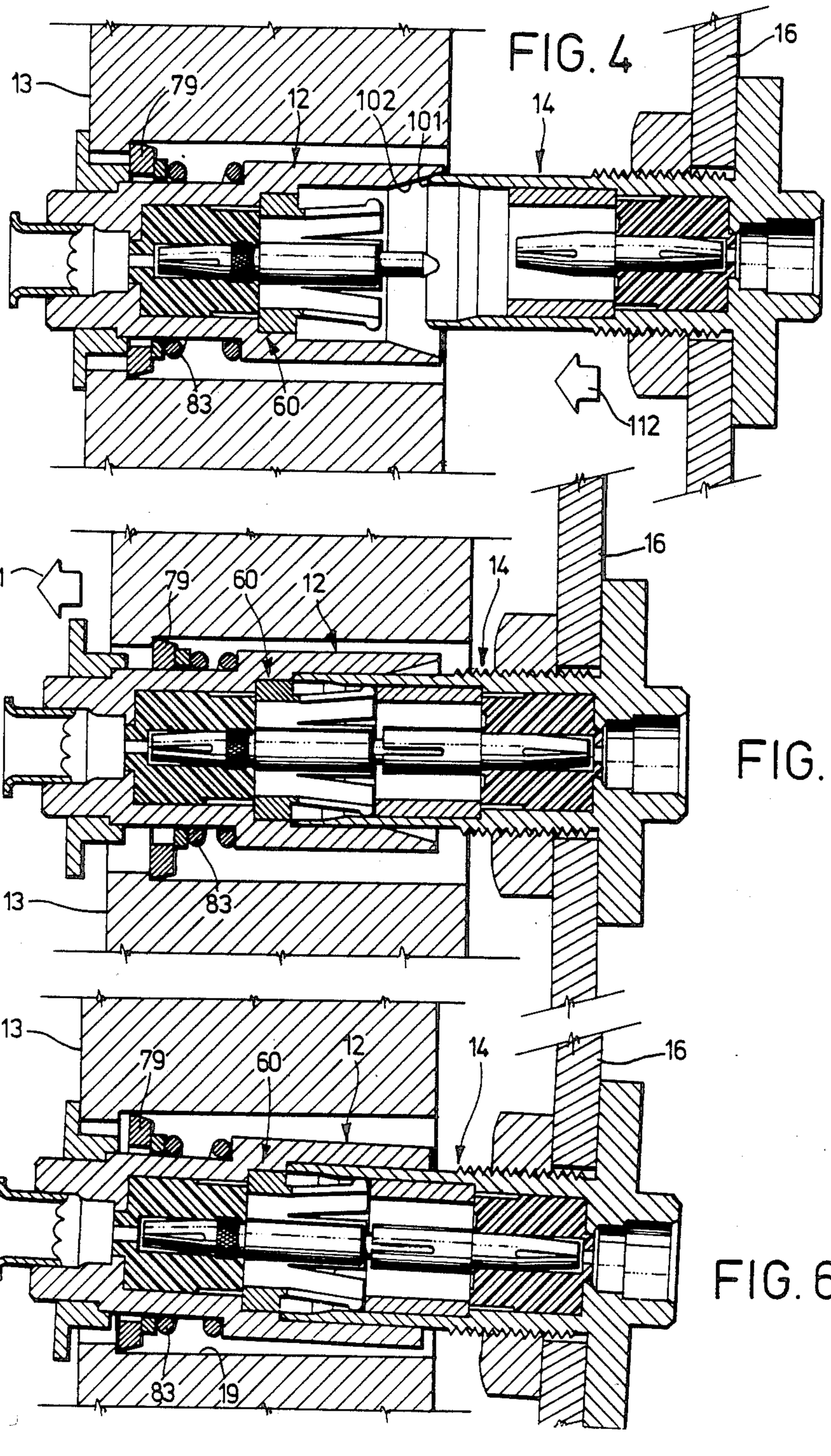

FIG. 4

FIG. 5

FIG. 6

FLOATING COAXIAL CONNECTOR

BACKGROUND OF THE INVENTION

The present invention relates generally to electrical connectors and, more particularly, to coaxial connectors of the panel-mounted type which can be reliably connected, both electrically and mechanically, under diverse conditions of misalignment.

The modularization of electronic equipment often requires the mating of large number of connectors to electrically couple one component or module to another component or module. Frequently, the connectors are mounted to a panel; e.g., to the wall of a housing or other enclosure, or to a printed circuit board; and the modules are electrically coupled by mating the connectors on one panel with complementary connectors on a second panel.

An important requirement of electrical connectors is to provide reliable, noise-free transmission of the electrical signals between the coupled components or modules. This requirement is particularly critical in high frequency applications wherein the connectors must provide reliable connections at frequencies of 18 GHz or more. In such applications, each connector must be properly mated, both electrically and mechanically, to obtain proper system operation.

In some prior systems, proper mating was assured by individually screwing each connector on the first panel to its complementary connector on the second panel. Such a procedure can be time-consuming when large numbers of connectors must be mated (in many applications, 50 to 100 or more connectors are mounted on each panel), and, in many applicatins, is precluded by the physical location of the connectors. In many installations, the connectors must be mated at sites that are surrounded by or enclosed by other parts of the system. In rack and panel systems, for example, wherein a rack member in the form of a drawer or the like is inserted into a panel member, access to the individual connectors is frequently not possible during mating.

In rack and panel systems and in other systems wherein connectors must be "blind-mated" to one another, directly pluggable connectors of the "quick-connect and disconnect" type are generally used. In "blind-mated" systems, however, each connector on one panel should be accurately aligned with its complementary connector on the other panel to obtain proper mating when the panels are brought together. In the past, accurate alignment, in turn, has required that the system be manufactured to precise tolerances which greatly increases the cost of manufacturing the system.

To reduce the problem of connector misalignment and to permit a relaxation in manufacturing tolerance requirements, the connectors on one of the panels have been mounted so that they are capable of moving or "floating" relative to the panel to automatically align themselves with their complementary connectors during mating. Examples of "floating" connectors are shown in U.S. Pat. Nos. 3,091,748; 3,094,364; 4,227,765 and 4,580,862. Such known "floating" connector designs cannot be easily installed in the field. Additionally, in many such known designs, the connectors cannot be assembled until they are mounted to a panel in the field, thus presenting a problem of missing parts and system assembly in, frequently, an undesirable environment. In other designs, the connectors must be secured to the panel by a plurality of screws of other fastening elements which increases assembly time and cost and is inconvenient. In many designs also, the floating connectors cannot maintain proper mating when the connectors are subjected to various external forces during use.

SUMMARY OF THE INVENTION

The present invention provides an electrical connector which is adapted to be easily inserted into and retained in an aperture in a panel without the use of tools or fasteners. The connector comprises a connector body having at least one electrically conductive contact therein, and means for mounting the connector body to the panel when the connector body is inserted into the aperture. The mounting means includes resilient means for securely fastening the connector the panel when the connector body is merely pushed into the aperture in the panel, while allowing the connector to float and automatically compensate for a misaligned mating connector. The resilient means is movable both radially and axially relative to the connector body for permitting insertion of the connector body into the aperture and for thereafter preventing the withdrawal of the connector body from the aperture, and for resiliently supporting the connector body for movement relative to the panel to permit automatic alignment of the connector body with a complementary connector during the mating thereof.

In accordance with a presently preferred embodiment, the panel retaining means comprises a first means for defining a first flange, and a second means comprising a split retention ring loosely surrounding the connector body and defining a second flange that is urged toward the first means by spring means. During mounting of the connector body to the panel, the split retention ring is resilient and is compressed inwardly to permit insertion of the connector body into the aperture of the panel. When the connector body is completely positioned in the aperture, however, the ring will expand outwardly to prevent withdrawal of the connector body from the aperture. The spring means preferably comprises a spring which urges the split retention ring toward the first flange. For example, a coil spring can be positioned between the connector body and the retention ring so that the connector body can move within the panel aperture axially, radially and angularly, with respect to the panel, permitting the connector body to automatically align itself with a complementary connector during mating, even if they do not share a common axis before mating.

The connector of the present invention comprises a fully assembled unit which can be mounted to a panel either during manufacture or in the field by simply inserting it into an aperture in the panel. Final assembly of the connector during mounted is not required, nor are separate bolts, screws, or other fastening elements needed to secure the connector to the panel. With the present invention, a large number of connectors can be mounted to a panel rapidly and with a minimum of inconvenience, and panels carrying large numbers of connectors to be connected can be mated easily even if complementary pairs of connectors do not share a common axis.

Further advantages and specific details of the invention will become apparent hereinafter in conjunction with the following detailed description of the presently preferred embodiment.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is a perspective view of a rack and panel connector system for mating a plurality of connectors of a presently preferred embodiment of the invention;

FIG. **2** is a cross-sectional view of the connectors of FIG. **1** mounted to their respective panels;

FIG. **3** is a partially exploded view of the plug connector of FIGS. **1** and **2**; and

FIGS. **4–6** illustrate the capability of the plug connector of FIGS. **1–3** to compensate for various conditions of misalignment during mating.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

FIG. **1** illustrates a portion of an electrical connector system **10** which includes a plurality of connectors **12** mounted to a first wall or panel **13**, and a like plurality of connectors **14** mounted to a second panel or wall **16**. FIG. **1** illustrates the invention in a rack and panel system in which panel **16** is incorporated within a movable rack member **15** in the form of a drawer, and panel **13** is incorporated within a stationary panel member **17**. As is well-known to those skilled in the art, rack member **15** is movable into panel member **17** in the direction indicated by arrow **20** so simultaneously mate the plurality of connectors **14** on panel **16** with the plurality of connectors **12** on panel **13** to complete electrical circuits (not shown) through the connectors.

Only a portion of rack and panel system **10** is illustrated in FIG. **1**. In practice, system **10** may include 50 to 100 or more connector pairs arranged in one or more rows or in other configurations on panel **13** and **16**.

As shown in FIG. **2**, connectors **14** may be jack connectors that extend through and are mounted within a plurality of apertures **18** in panel **16**, and connectors **12** may be plug connectors that extend through and are mounted within a plurality of apertures **19** in panel **13**. As will be explained hereinafter, panel **13** is preferably of a sufficient thickness that plug connectors **12** will be substantially fully positioned within apertures **19**.

The connectors **12** and **14** comprise coaxial connectors adapted to terminate and connect a pair of coaxial cables **21** and **22**. (The cables are not shown in FIG. **1**, for clarity).

Jack connector **14** is of generally known construction and need not be described in great detail. Connector **14** includes an electrically conductive, center contact **31** supported axially within and electrically insulated from an electrically conductive outer shell **32**. The connector is attached to the end of a coaxial cable **22** as known to those skilled in the art. Center contact **31** is electrically connected to the center conductor **30** of cable **22** and the outer conductive shell **32** is electrically connected to the outer conductor **35** of cable **22**. The center contact **31** is electrically insulated from the outer shell **32** by an annular spacer or plug **33** formed of a suitable dielectric material. A tubular-shaped, electrically conductive outer contact **34** is positioned within shell **32** and is electrically coupled to outer conductor **35** via shell **32**.

Outer shell **32** has an integral, outwardly extending, annular flange **36** adjacent the rear end thereof. At least a portion of the outer surface of shell **32** is also threaded as shown at **37**. To mount jack connector **14** to panel **16**, the connector is inserted into an aperture **18** in panel **16** in the direction indicated by arrow **38** until flange **36** contacts surface **39** of panel **16**. A lock-nut **40** is then threaded onto the threaded portion **37** of shell **32** and tightened until panel **16** is firmly retained between flange **36** and lock-nut **40**. After fastening, jack connector **14** is rigidly mounted to panel **16** and unable to move with respect to the panel.

Plug connector **12**, illustrated in cross-section in FIG. **2**, is also illustrated in exploded form in FIG. **3**. Connector **12** comprises a connector body portion **60** which includes an outer shell or housing **61** of generally cylindrical shape, having an axial bore **62** of varying cross-sectional diameter extending therethrough from rear end **63** to front end **64** thereof. Connector body **61** is attached to the end of a coaxial cable **21** entering into the connector body **61** from rear end **63**. Cable **21** is supported by a grip ring **66** which is press-fit or otherwise secured in rear passageway portion **62***a* as shown. The end of outer conductor **26** of the coaxial cable **21** is exposed and tightly surrounded by grip ring **66** when the grip ring **66** is moved forwardly to wedge against the internal wall of bore portion **62**a to provide electrical coupling between the outer conductor **26** and the outer shell **61**.

Connector **12** also comprises a centrally located electrical contact **67**, having a rearward portion **67***a* adapted to accept the center conductor of the coaxial cable. The center conductor **27** of coaxial cable **21** is adapted to extend into portion **67***a* of center contact **67** and be retained therein by force fit or the like. Center contact **67** is supportedd axially within outer shell **61** by an annular dielectric member **68** which both supports center contact **67** and electrically insulates it from outer shell **61**. An exposed pin portion **67***b* of center contact **67** extends outwardly of the dielectric member to adjacent front end **64** of connector body portion **60**, and is adapted to be received by center socket contact **31** in jack connector **14** when the two connectors are mated.

An outer contact **69** surrounds exposed center contact portion **67***b*. Outer contact **69** is electrically insulated from center contact portion **67***b* by air, and includes a plurality of spring fingers **69***a* which are adapted to electrically contact outer contact **34** and shell **32** of jack connector **14** upon mating of the connectors as shown in FIGS. **5** and **6**. As shown, the spring fingers **69***a* diverge radially. In practice, they may be deflected radially inward by the contact **34** to project axially of the jack connector **14** without the radial divergence as shown.

A bushing **76** surrounds connector body portion **60** adjacent the rear end thereof. Bushing **76** is rigidly secured to shell **61** of body portion **60** and includes an outwardly extending annular flange **77**.

The connector **12** is retained in panel **13** and panel aperture **19** by resilient means which permits insertion and mounting of the connector **12** to the panel **13** without tools, and automatic alignment of connector **12**, when mounted, to reliably mate with connector **14** if connectors **12** and **14** do not share a common axis and connector **14** is substantially misaligned with connector **12**. The resilient means includes a radially resilient part **79** and an axially resilient part **83**. The radially resilient part **79** of the resilient means is a C-shaped, split retention ring loosely positioned around shell **61**. Retention ring **79** provides a second flange spaced from the first flange **77** to define an annular groove **81** therebetween. The axially resilient part **83** of the resilient means is a coil spring **83** which also surrounds outer shell **61**, as shown. One end **83***a* of spring **83** is biased against ring **79** via a washer **84**, which is preferably positioned be-

tween the spring **83** and the retention ring **79**. The opposite end **83**b of spring **83** is in contact with and biased against shoulder **86** on shell **61**. The length of spring **83** is such that it is compressed when positioned between ring **79** and shell **61**. Retention ring **79** is thus forced toward the rear of the connector in the direction of the lower edge **82** of bushing **76**.

Plug connector **12** is thus adapted to be mounted to panel **13** and supported within an aperture **19**. To mount connector **12** to panel **13**, connector **12** is inserted into an aperture **19** in panel **13** in the direction indicated by arrow **85**. The diameter of the connector body portion **60** is such that it will fit within aperture **19** with a slight clearance, and can be pushed substantially fully into aperture **19** until the split retention ring **79** encounters peripheral edge **88** of panel **13**. Peripheral edge **88** will impinge upon the tapered surface **87** on retention ring **79**, and upon further movement of connector **12** into aperture **19**, edge **82** will urge ring **78** against the inwardly extending flange **91** of aperture **19**. Ring **79** will be compressed inwardly to permit the retention ring **79** to clear the edge **88** and flange **91** of aperture **19**, and insertion will continue until rigid first flange **77** impinges upon surface **89** of panel **13**. When connector **12** is fully inserted in aperture **19**, split retention ring **79** will clear internal shoulder **90** of inwardly extending flange **91** within aperture **19** and quickly expand outwardly to the position shown in FIG. **2** to lock the inwardly extending flange **91** of aperture **19** within the annular groove **81** between the retention ring **79** and the flange **77**. Inwardly extending flange **91** has an axial length somewhat less than the axial length between flange **77** and edge **82** of bushing **76**. The connector will thus be retained within the aperture **19** of panel **11** without the necessity of tools, bolts or other fastening elements normally needed to attach a connector to a panel. With the present invention, therefore, the entire connector **12** can be assembled together as a unit in the factory and shipped into the field in fully-assembled form for mounting to a panel. It is not necessary to ship the connector partially disassembled or to provide separate nuts and bolts or other fastening elements to attach the connector to the panel.

As a result of its resilient mounting means, i.e., split retention ring **79** and coil spring **83**, connector body portion **60** is floatingly mounted within aperture **19** in panel **11** for movement axially, radially and angularly relative to panel **13**, and is capable of automatically aligning itself with fixed jack connector **14** upon mating.

Specifically, if connectors **12** and **14** are radially misaligned, the connector body **60** can shift radially to the extent permitted by the clearance between the inwardly extending flange **91** of the aperture **19** and the connector body portion **61** through the resilience of spring **83**, as is illustrated in FIG. **4**. When the jack and plug connectors are radially misaligned, front edge **101** of jack connector **14** will impinge upon tapered surface **102** of plug connector **12**, and surface **102** will guide the two connectors into radial alignment for proper mating.

If connectors **12** and **14** are axially misaligned, connector body portion **60** is capable of shifting axially in the direction indicated by arrow **111** in FIG. **5** through the compression of coil spring **83**. Compensation for axial misalignment permits the jack connector **14** to be fully inserted into the plug connector during mating and minimizes the possibility of breakage in achieving proper electrical coupling of both the outer and center contacts in the two connectors.

If connectors **12** and **14** are angularly misaligned, connector body portion **60** is capable of tilting to a slight extent as illustrated in FIG. **6**. This capability exists because split retention ring **79** is resiliently supported on the connector body and can shift angularly as shown in FIG. **6**. The extent of angular movement of the connector **12** is limited primarily by the diameter of aperture **19**. By enclosing the floating connector body substantially fully within aperture **19**, the connector body is prevented from excessive angular movement that can damage the connector or the electrical and mechanical connection between the jack and plug connectors.

In the embodiment illustrated herein, the connector body **60** is capable of up to 0.020 inches of radial movement and up to 0.060 inches of axial movement relative to panel **13**, and is capable of an angular movement corresponding to these axial and radial movements. These numbers are exemplary only as the connector can be modified to provide greater or lesser movement depending on the requirements of the particular application in which it is used.

To remove the plug connector **12** from panel **11**, it is only necessary to compress the split retention ring **79** sufficiently to allow the entire connector **12** to be withdrawn from the panel in the direction opposite that of arrow **85** in FIG. **2**. This can be done by inserting an appropriate tool into aperture **19** to engage and compress the resilient split retention ring **79** until it can be withdrawn through the flange **91** of aperture **19**.

While that has been described constitutes a presently most preferred embodiment of the invention, it should be understood that the invention can take various other forms. For example, although the invention is described as being incorporated into a coaxial connector assembly, the invention could also be practiced with triaxial and single contact connectors. Furthermore, other types of springs can be used to floatingly mount connector body portion **60** relative to panel **13**. In addition, although a plug connector is described as the floating connector, it is possible, if desired, to design a jack connector to be floating. It is also possible to make both connectors floating for selected applications.

Because the invention can take many other forms, it should be understood that the invention should be limited only insofar as is required by the scope of the following claims.

We claim:

1. An electrical connector adapted to be inserted into and retained in an aperture in a panel comprising:

a connector body having at least one electrically conductive contact therein,

and mounting means for mounting said connector body to said panel when said connector body is positioned in said aperture,

said mounting means including first and second annular flanges extending outwardly from said connector body for receiving said panel therebetween when said connector body is positioned in said aperture,

said second annular flange being moveable relative to the connector body for permitting insertion of said connector body into said aperture and for thereafter preventing the withdrawal of said connector body from said aperture,

said mounting means further including spring means positioned between said connector body and said second annular flange for resilently supporting said connector body for movement relative to said panel for automatically aligning said connector body with a complementary connector during mating of said connector body with said complementary connector,

said second annular flange comprises a split retention ring surrounding said connector body,

said split retention ring being capable of being compressed inwardly during insertion of said connector body into said aperture to permit insertion of said connector body into said aperture, and of thereafter expanding outwardly for preventing the withdrawal of said connector from said aperture,

and, said spring means comprises a coil spring having one end biased against said connector body and having an opposite end biased against said split retention ring.

2. The connector of claim **1** wherein said split retention ring includes a tapered surface portion for contacting the edge of said aperture during insertion of said connector body into said aperture, the edge of said aperture compressing said split retention ring for permitting insertion of said connector body into said apperture.

3. The connector of claim **1** wherein the thickness of said panel is such that said connector body is substantially fully positioned within said aperture when said connector is mounted to said panel.

4. The connector of claim **3** wherein said aperture includes a portion of reduced diameter defining an inwardly extending flange and wherein said split retention ring is compressed inwardly by said inwardly extending flange during insertion of said connector body into said aperture to permit insertion of said connector body into said aperture, and said split retension ring expands outwardly upon clearing said inwardly extending flange to retain said inwardly extending flange between said split retention ring and said first flange.

5. The connector of claim **1** wherein said connector comprises a coaxial connector.

6. A coaxial electrical connector adapted to be inserted into and retained in an aperture in a panel comprising:

a connector body, said connector body including at least one outer contact:

a center contact;

means for mounting said connector body to said panel, said mounting means including:

means for defining a first peripheral flange extending outwardly from said connector body;

a split retention ring loosely surrounding said connector body and defining a second peripheral flange extending outwardly from said connector body, said first flange and said split retention ring defining an annular groove therebetween for receipt of said panel to retain said connector on said panel, said retention ring being compressible inwardly relative to said connector body for permitting insertion of said connector body into said aperture, and thereafter expanding outwardly upon insertion of said connector body into said aperture for retaining said panel within said annular groove for preventing the withdrawal of said connector from said panel; and

a coil spring surrounding said connector body and having one end biased against said connector body and the opposite end biased against said retention ring for resiliently supporting said connector body for movement axially and radially relative to said panel for automatically aligning said connector body with a complimentary connector during mating of said connector body with said complimentary connector.

7. The coaxial connector of claim **6** wherein said split retention ring includes a tapered surface portion for contacting the edge of said aperture during insertion of said connector body into said aperture, the edge of said aperture compressing said split retention ring during insertion of said connector body into said aperture to compress said split retention ring for permitting insertion of said connector body into said aperture.

8. The coaxial connector of claim **6** wherein said panel has a thickness such that said connector body is substantially fully positioned within said aperture when said connector is mounted to said panel, and wherein said aperture includes a portion of reduced diameter for defining an inwardly extending flange, said split retention ring being compressed by said inwardly extending flange during insertion of said connector body into said aperture until said split retention ring clears said inwardly extending flange at which time said retention ring expands outwardly to retain said inwardly extending flange between said first flange on said connector body and said split retention ring for retaining said connector body within said aperture.

9. An electrical connector as recited in claim **6**, and further including: an axial passageway through the connector body, a rearward portion of said center contact axially within the connector body, a coaxial cable adapted for entering the passageway, said coaxial cable having a center conductor fitting in said rearward portion of said center contact and having an outer conductor exposed within said passageway, and a grip ring wedged against an internal wall of said passageway and surrounding the outer conductor to provide an electrical coupling of said outer conductor and said outer body.

10. An electrical connector as recited in claim **6**, and further including: a tapered surface on a front end of said connector body for impingement by said complementary connector during said mating.

* * * * *